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Flow Visualization Fall 2020

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Music by Willa Emmitt

In order to capture the science of cymatics, the phenomena of visualizing sound, I used water, food coloring, and a waterproof speaker. I did experiment with photographing cymatics without food coloring and with a diluted version of the dye, however, I found the aesthetics to be most powerful when the pure concentrated food coloring was dropped into the water. Through fluid dynamics and the phenomenon of cymatics, I was able to capture a video that helps visualize sound.

The project was assembled so that about three tablespoons of water were placed on top of the passive radiator of my JBL Charge 3 speaker with one drop of food coloring set in the center. As seen in figure 1, the diagram below. After positioning the fluids on the silent speaker, I pressed play on the song “Pink Cloud Kisses” by Willa Emmitt the sound waves from the music vibrated the passive radiator on which the fluids were sitting on, resulting in the nodal patterns visible on the water’s surface and the wispy flow of the dye’s expansion. This wonder of being able to visualize sound was studied by early scientist, Ernst Chladni. Chladni’s law can be applied when analyzing the physics behind my apparatus. The law is stated through the equation $f=C(m+2n)^a$, where C and a are coefficients depending on the properties of the vibrating plate. In this case, the passive radiator the fluids were positioned on was flat and circular, meaning the ‘a’ value would be around 2 (Rossing, Fletcher 2011). When trying to understand the fundamental

principles of my sound wave experiment through cymatics, Faraday waves must also be considered. Faraday waves can be seen in my flow apparatus as the wave patterns produced by the passive radiator reaching various frequencies and accelerations (Gu, Rvachov, Sathananthan 2009). The movements created by the sine waves in sound cause the passive radiator to vibrate creating standing waves along the surface of the water. The various frequencies and accelerations create patterns that beautifully illustrate the sound playing from the speaker.

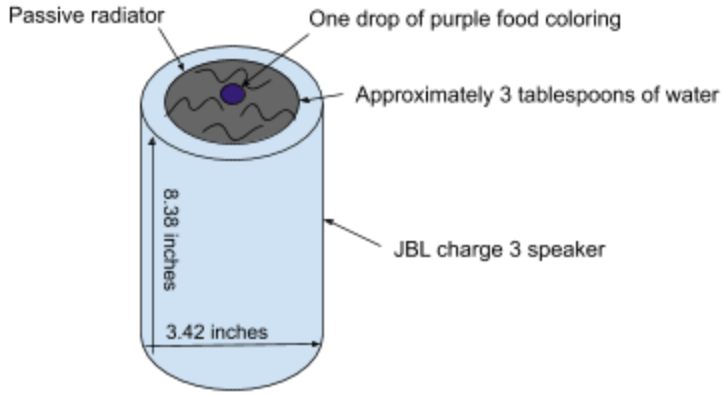

figure 1.

Although this experiment would demonstrate the same physics if it was performed without food coloring, the food coloring added another element of flow as it dispersed throughout the water as well as improving the aesthetics of the apparatus as a whole. I used one drop of the purple dye from the Wilton brand neon gel food color set from Target in this variation of the Image-Video 1 experiment. The lighting used for this experiment was the natural day lighting in Boulder Colorado at 4:07 pm. For this iteration of the observation of sound the speaker was placed in the windowsill with the blinds open and the flash on my camera off, which I found to be the best lighting for visualizing the faraday waves without distracting reflections.

For the highest quality video that kept the waves in focus I tried to position the lens as close as possible to the surface of the water in hopes to only have the top of the speaker in frame, however this was extremely difficult so I ended up taking the video approximately 4 inches from the water's surface and cropping the video in iMovie so the top of the speaker covered the whole frame. As seen in figure 1 the top of the speaker is 3.42 inches, so the final frame captures a field of view of approximately three and a half inches by three and a half inches. I shot and edited most of this version of the project on my iphone Xs. The edits I made on the photos app on my iphone are as follows: -31 exposure, -40 highlights, -9 shadows, 24 contrast, -27 brightness, 100 black point, 29 saturation, and 8 warmth. After making these edits I then transferred the video to my laptop and finished editing in iMovie. Through the iMovie software I was able to crop the video and insert higher quality background music.

Overall, I am pleased with the final version of this video project especially considering I had little experience with video editing. I love how the video so beautifully captures the voice of my talented friend, Willa Emmitt, while simultaneously unveiling the physics of cymatics. In my opinion the fluid physics are excellently demonstrated in this video and even heightened with the use of food coloring. I do wish the video could have been more focused on the peaks of the waves as they formed, slow motion could have helped create a more focused look, but then the music wouldn't match up and the flow visualization would have lacked the sound and visual connection. To develop this idea further I would experiment with different fluids to see how density impacts the faraday waves.

References:

Gu, Ruo Yu, et al. “Faraday Waves .” *FAR Faraday Waves* , University of Toronto Physics , 2009, www8.physics.utoronto.ca/~phy326/far/far.pdf.

Rossing, Thomas D., and Neville H. Fletcher. *Principles of Vibration and Sound*. Springer, 2011.